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# EFFICIENT DATA ASSIMILATION IN OCEAN PREDICTION

**PI:** Jose' M. F. Moura
**Address:** Department of Electrical and Computer Engineering
Carnegie Mellon University
5000 Forbes Av.
Pittsburgh PA 15213-3890
**Phone:** (412)268-6341
**Fax:** (412)268-3890
**email:** moura@ece.cmu.edu
**Award Number:** N00014-97-1-0800

## LONG-TERM GOALS

To develop efficient algorithms for data assimilation in ocean circulation models.

## OBJECTIVES

To interface efficient and accurate data assimilation methods based on the Kalman-Bucy filter (KBF) with the NRL-Stennis ocean circulation model and carry out extensive data/ model studies to understand issues of resolution and convergence in ocean model nowcasting. Data sets of interest include altimetry, XBT, and possibly IR data.

## APPROACH

We apply the extended Kalman-Bucy filter (KBf) to assimilate observational data with the predictions provided by ocean circulation models. Since these models are highly nonlinear, we use first dynamic linearization, so that the assimilated data is the sum of the field as predicted by the underlying model with a correction that is provided by the KBf. However, the large number of grid points in the grid discretizing the ocean basin precludes the direct application of the KBf.

In our approach, we exploit the fact that the ocean circulation models are difference equations resulting from the discretization of partial differential equations. This is reflected in the block structure of the relevant system matrices. Combining this structure with the sparseness of the measurements and certain realistic simplifying assumptions, we can derive implementations for the KBf that are computationally fast and efficient. Depending on the measurement programs, we have block and scalar KBf implementations.

This work teams the PI and Dr. Amir Asif who developed in his PhD thesis the fast KBf implementations with Dr. Hurlburt and Mr. Rhodes from the US Naval Research Laboratory at Stennis Center, Mississipi.

## WORK COMPLETED

The start of the project was initially delayed because of problems encountered by Dr. Asif in joining CMU. These problems have now been resolved. During this initial period we have started the task of developing the software implementing the block KBf.

## RESULTS

Since the project has started very recently, the results relate to the analysis that we can achieve several orders of magnitude efficiency over the direct implementation of the KBf. For example for single layer models we can show that our computational savings are O(I^2) where I is the linear dimension of the ocean basin (assumed for simplicity to be square).

## IMPACT/APPLICATIONS

Our results will demonstrate the viability of applying sophisticated data assimilation algorithms to ocean circulation. By combining the data with the predictions of the circulation models, we aim at achieving better resolution than currently achieved by the Navy ocean prediction models.

## TRANSITIONS

The work is in direct collaboration with Dr. Hurlburt and Mr. Rhodes from the NRL at Stennis Space Research Center, Mississippi. So, we expect that our results will have direct impact on the Navy models.

## RELATED PROJECTS

## REFERENCES

Amir Asif and Jose' M. F. Moura, "Data assimilation in large time varying multidimensional fields," Technical Report, Department of Electrical and Computer Engineering, CMU, submitted for publication, under revision, 30 pages.

Amir Asif and Jose' M. F. Moura, "Fast recursive reconstruction of large time varying multidimensional fields," IEEE International Conference on Acoustics, Speech, and Signal Processing, ICASSP'97, 4 pages.